The development of an efficient wild boar meat supply chain

– Opportunities, challenges, and limitations from a case study of Swedish game suppliers and hunters.

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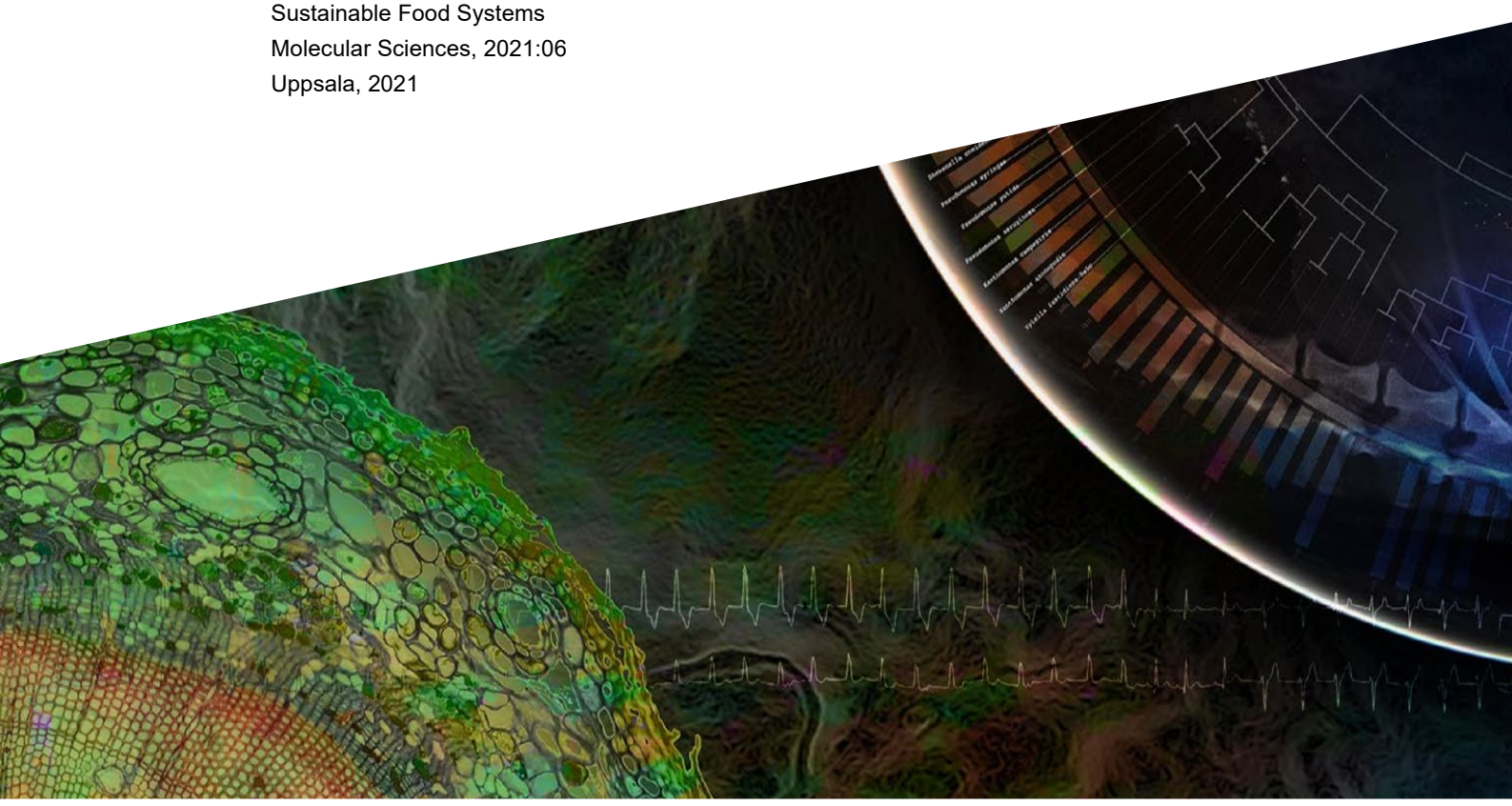

The development of an efficient wild boar meat supply chain
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Utvecklingen av en effektiv livsmedelskedja för vildsvinskött
- Möjligheter, utmaningar och begränsningar från en fallstudie av svenska vilthandlare och jägare.

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Abstract

The purpose of this study is to create a better understanding of how an efficient supply chain of wild boar meat can be developed in Sweden. The sales of wild boar meat are regulated by legislations to assure food safety since the meat can contain pathogens, parasites, compared to most other Swedish game species. Nowadays, only 15 percent of the harvested wild boar meat reaches the wild boar market, which can be seen as a market failure. Therefore, the following research question has been used to fulfil the purpose: "*What are the main factors that inhibits wild boar meat from reaching the market?*". The data collection consisted of interviews with game dealers as well a survey conducted on hunters.

The findings show that two main factors that inhibit wild boar meat from reaching the market nowadays, which are the following; the pricing discrepancy and the geographical distance between hunters and game dealers. Moreover, the study also shows that the long-term demand for wild boar meat can potentially increase if wild board meat is served in public kitchens. The study also concludes that the proposed legislation changes, allowing hunters to sell their wild boar meat directly to consumers and restaurants, is a trade-off between increased supply and food safety since potentially hazardous meat will reach the market. Lastly, the study found that the development of a more efficient wild boar supply chain will contribute to long term sustainability since it increases social, environmental and economic sustainability.

Sammanfattning

Syftet med denna studie har varit att skapa en bättre förståelse för hur en effektiv livsmedelskedja för vildsvinskött kan utvecklas i Sverige. Försäljningen av vildsvinskött är reglerad enligt lag för att värna om livsmedelssäkerheten eftersom köttet kan innehålla parasiter och patogener, till skillnad från många andra vilda djurarter i Sverige. I nuläget når enbart 15 procent av jägarnas vildsvinskött den offentliga marknaden, vilket kan ses som ett marknadsmisslyckande. Därmed har följande forskningsfråga används för att besvara syftet: ”*Vilka är de huvudsakliga faktorerna som förhindrar vildsvinskött att nå marknaden?*”. Datainsamlingen utfördes genom intervjuer med vilthandlare och en enkätstudie med jägare.

Studien visar på att det finns två huvudsakliga faktorer i nuläget som förhindrar vildsvinskött att nå marknaden; prisdiskrepansen likväl som det geografiska avståndet mellan jägare och vilthandlare. Studien påvisar ytterligare att efterfrågan av vildsvinskött kan på lång sikt eventuellt ökas genom att servera vildsvinskött i offentliga kök. Vidare fastslås att den föreslagna nya lagstiftningen som underlättar för jägare att sälja vildsvinskött till privatpersoner och restauranger är en avvägning mellan ökat utbud och livsmedelssäkerhet eftersom skadligt kött kommer ut på marknaden. Avslutningsvis kan en utveckling av en effektivare livsmedelskedja för vildsvinskött bidra till långsiktig hållbarhet då det ökar social, miljömässig och ekonomisk hållbarhet.

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1 Introduction

Food consumption is one of the most influencing factors to climate change (UNEP 2010) and the agricultural sector is responsible for more than 22 percent of the global greenhouse gas emissions (McMichael 2007; FAO 2016). The livestock production represents 80 percent of the total amount of emissions (FAO 2016) and is therefore considered one of the greatest contributor to global warming (Gerber et al. 2013). In Europe the food consumption is estimated to account for 20 to 60 percent of the total environmental impacts (Weidema et al. 2008).

In recent years, the growing consumer awareness regarding the impact of food on the environment has resulted in an increased demand for organic and eco-friendly products (Falguera et al. 2012), such as hunted game meat (Gougen et al, 2018; Hoffman & Wiklund 2006). Generally, wild game meat can be considered to be more climate friendly than meat from livestock production systems since wild game species, in contrast to livestock, doesn't require resource intense inputs such as feed (Röös 2014). However, the climate impact can vary depending on how the wild game meat is harvested (Malmfors & Wiklund 2014), for instance in cases where motor vehicles are used by the hunter for transportation on long distances. Consumer awareness in recent years can, however, also be linked to most wild game meats being lean and rich in polyunsaturated fats such as Omega-3 fats (Hoffman & Wiklund 2006).

In Sweden, the wild boar population has been growing rapidly during the past 50 years and the same increase has also been observed in many other wild game species (Naturvårdsverket 2020). In line with the growing population, the culling has increased; from 300 killed wild boars in 1990 to just over 112 000 in 2018 (ibid.). However, only 15 percent of the harvested wild boar meat reaches retail stores and restaurants (Jordbruksverket 2013), which can be seen as a market failure. Thus, the existing game supply chain is analysed to understand how it can be more efficient.

1.1 Background

The wild boar (*Sus scrofa*) is the ancestor of domestic pigs and was eradicated in Sweden as early as in the 1700 century due to its extensive hunting (Naturvårdsverket 2020). In 1970, the wild boar was reintroduced in Sweden through enclosures built for hunting purposes (Gren et al. 2019; Naturvårdsverket 2020). However, some wild boars managed to escape from the enclosures and today's population descend from these wild boars (Naturvårdsverket 2020; Tham 2004). Nowadays, the wild boar population is spread throughout the southern and middle part of Sweden and extending up to Dalarna county (ibid.).

Since the 1970's, the wild boar population has increased rapidly and today the Swedish population is estimated to consist of approximately 350,000 individuals (Thulin & Röcklinsberg 2020). In contrast, studies show that on average 33 percent of the Swedish inhabitants are afraid of meeting a wild boar in the forest (Ericsson et al. 2010). Many farmers and house owners have also shown to have a negative view on wild boars, as they damage agricultural fields and gardens when rooting for food (Månsson et al. 2010; Gren et al. 2019). In addition, traffic accidents involving wild boars are increasing; in 2018 nearly 7000 accidents occurred compared to 700 in 1990 (Gren et al. 2019). In 2015, the total economic cost caused by wild boars was estimated to 1,315 billion SEK (ibid.). Combined, the above can have an impact on society's perception of wild boar meat as being something negative.

However, wild boars do not only cause damage. In fact, studies show that their rooting has benefits on biodiversity (Brunet et al. 2016; Welander 2000; Wiklund & Malmfors 2014; Jordbruksverket 2013). Wild boars also generate economic value deriving from the hunter's willingness to pay for hunting as well as the sales of wild boar meat (Gren et al. 2019; Wiklund & Malmfors 2014). In 2018, Gren et al. estimated the total revenue from wild boars amounting to 0,235 billion SEK and argued that the revenue compared to the cost caused by the wild boar's damages is as much as three times higher than the same comparison for other wild game species. Nevertheless, the fact that only 15 percent of the hunted wild boar meat

reaches retail stores and restaurants indicates that the majority of the wild boar meat is kept by the hunters or sold on the black market (Wiklund & Malmfors 2014). The wild boar population is increasing at a higher pace than any other wild game specie, requiring an efficient and adaptive management (ibid.). According to the National Wild Boar Management Plan from Naturvårdsverket (2020), the aim is to create a long term sustainable management that minimizes the agricultural damages and traffic accidents caused by wild boars (Naturvårdsverket 2020). Two of the main actions to achieve these goals are to increase market supply and servings of wild boar meat in the public sector (ibid.).

Unlike most other Swedish wild game species there are regulations restricting the sales of wild boar meat (Wiklund & Malmfors 2014; Naturvårdsverket 2020). The purpose of the regulations is to increase food safety as wild boars can carry pathogens such as Salmonella spp, Yersinna spp and the parasitic roundworm *Trichinella* (Livsmedelsverket 2019; Naturvårdsverket 2020), as well as parasites such as *Toxoplasma gondii* (EFSA 2013). Wild boars can, in addition, contain radioactive levels of cesium, especially in the counties of Uppsala, Gävleborg and Västmandland (Livsmedelsverket 2019; Malmfors & Wiklund 2014; Naturvårdsverket 2020). Another food safety aspect regarding wild boar and other wild game meat is the frequent use of lead-based bullets used when shooting the animal, resulting in some cases to meat containing lead fragments (Arnemo et al. 2016).

In order to assure food safety, the sales of wild boar meat are regulated by the Regulation 2016/429 of the European Parliament, entailing that wild boar meat must be evaluated in an approved game management facility before being sold to restaurants, retailers and consumers. On commission by the Swedish government, the Swedish Food Agency is currently developing new systems to manage food safety issues in relation to wild boar meat and aiming to propose a new legislation enabling hunters to sell a small amount of meat directly to the end consumer without interfering with a game management facility (Regeringen 2020). On the other hand, Wiklund & Malmfors (2014) argue that most of the game dealers, kitchen chefs and

people with vast knowledge and experience of meat handling are concerned with the hunter's potential lack of knowledge of different slaughter methods and meat handling. From this perspective, the lack of knowledge might be a serious food safety issue that should be taken into account when working towards enabling hunters to sell directly to end consumers.

1.2 Problem

The lack of a structured food supply chain for hunted wild game meat is often limiting the expansion of wild game meat sales (Marescotti et al. 2019). The wild boar population has increased dramatically during the past 50 years and the same applies to the culling (Naturvårdsverket 2020; Wiklund & Malmfors 2014). However, only a fraction of the hunted meat reaches the restaurants and retailers (Jordbruksverket 2013). A small part of the meat is kept by the hunters (Wiklund & Malmfors 2014), but it is unknown what hunters do with the meat not kept by them. This is concerning from both a food safety and a food security perspective. Therefore, this thesis will examine how a more efficient wild boar meat supply chain can be developed in order to assure food safety and food security. This goal will be achieved by analysing the existing market through a food system approach (FSA).

1.3 Aim and research questions

The purpose of this study is to create a better understanding of how an efficient supply chain of wild boar meat can be developed. The study is based on the following research question:

- *What are the main factors that inhibits wild boar meat from reaching the market?*

2 Theoretical framework

2.1 Food systems and sustainability

To create a better understanding of how the wild boar supply chain can be developed, it is necessary to locate the wild boar into a food system context. Food systems can be described as systems that incorporate all actors and their interrelated activities linked to production, processing, distribution and consumption of food products from agriculture, fisheries and forestry (FAO 2018; UNEP 2016). The main food system is then built on sub-systems such as farming and processing systems. This system then connects to other important systems, for instance trade systems and energy systems. As all systems are interrelated, visible changes in one part of the food system will entail changes in a sub-system. Within the food system, most activities contribute to food security, however, the outcome is often related to social and environmental concerns (Ericksen et al. 2009).

According to the Food and Agricultural Organisation, FAO (2018), the main purpose of sustainable food is providing food security as well as nutritious food without compromising the social, environmental and economic conditions to produce food for future generations (ibid.). A sustainable food system should therefore foster economic, environmental and social sustainability. These three aspects of sustainability are the aspects given in the Triple Bottom Line Concept founded by Elkington (1999). However, food systems can vary in size, from large global systems to national and local systems (Martinez et al. 2010). The global food system relies on long-distance transport networks which results in a high rate of Greenhouse Gas (GHG) emissions (FAO, 2018; Pirog et al. 2001).

Tansey & Worsley (2014) argues that there are three important aspects in a food system; biological, economic and political, as well as social and cultural. The biological aspects represent the living organisms and processes that are used to produce food. It also involves the ecological impact caused by activities within the food system. The economic and political aspects refer to the power and control from

governments and other stakeholders. Lastly, the social and cultural aspects are the personal values, cultures and behavioural aspects relating to how people use food. In addition, Lipinski et al. (2013) and the FAO (2018) point out another important aspect in food systems, being that the food system shall foster food safety, meaning that the produced food should be healthy and safe to consume. Moreover, according to Ericksen et al. (2010) and Stamoulis & Zezza (2003), another aspect is to enhance food security, without having an impact on the environment and compromising social welfare.

2.2 Food supply chains and livestock production

One of the central parts in the food system is the food supply chain, which includes all processes refining the primary input into a completed product that reaches the end consumer (Beamon 1999). Food chains can vary in complexity and size and Marsden et al. (2000) describe short food supply chains as linear and as direct links between the producer and the end consumer. In contrast, the traditional food chain consists of more actors and starts with primary producers, followed by processors, distributors, retailers and lastly consumers (Georgiadis et al. 2005; Malik et al. 2018).

Figure 1 Illustration of the food supply chain by Malik et al. (2018)

Studies and climate impact assessments show that the highest environmental impact occurs in the global primary production due to the high amount of input-resources that are required (UNEP 2016; Gerber et al. 2013). The demand for meat and dairy

products is a major driver to climate change (Bailey et al. 2014; UNEP 2016). Since 1980, the consumption of frozen and fresh meat from livestock production has increased by 78 percent as the consumption in 2019 amounted to 47 kilograms per person per year (Jordbruksverket 2019). At the same time the official statistics from Jordbruksverket show that the consumption of wild game meat has decreased with 25 percent from 2,5 to 1,8 kilograms per person per year in 2019 (www.jordbruksverket.se.).

The global livestock production represents 14.5 percent of the global GHG emissions (Bailey et al. 2014) and the emissions mainly derives from etheric fermentation and the manure (FAO 2016). Moreover, the increased livestock production has resulted in increased land use and deforestation which is estimated to account for 30 percent of the global biodiversity loss (Bailey et al. 2014).

2.3 Food losses and waste

To minimize the environmental impact from food production it is important to minimize food loss and waste (FAO, 2018; Lipinski et al. 2013; Godfray et al. 2010). Lipinski et al. (2013) distinguishes the concepts by defining food loss as food that is spoiled before it reaches the consumer due to a lack of quality. Food waste on the other hand, refers to food of good quality that is ready to be consumed but somehow is forsaken before it is consumed. Therefore, a well-known solution to increase the food supply and at the same time limit the environmental impact is to reduce food losses and food waste (FAO 2018; Godfrey et al. 2010).

3 Method

3.1 Literature review

Throughout this study, the literature review consists of scientific articles and publications regarding food systems, wild boar management and biology, as well as game management in general. The review aims to explain existing research in the research field and to synthesise food system theories and wild boar game supply chains that are not integrated. Literature reviews can either have a narrative or a systematic approach (Bryman & Bell 2017; Green et al. 2006) and throughout this study a narrative approach was chosen. The narrative approach is an organic process in which the researcher searches for knowledge, without knowing in advance what literature to search for (Green et al. 2006). The starting point of the literature search regarding wild boar management have been reports from Naturvårdsverket (2018 & 2020) and Jordbruksverket (2013). The initial search regarding food system knowledge was based on reports from UNEP (2016) and FAO (2018). The following search databases were used during the literature search: Google Scholar, Primo, Web of Science and Epsilon Archive for Student Projects - SLU. The search words have been: Food systems, Food supply chain, Food safety, Game management, Game supply chains, Wild boar management and Wild boar supply chain.

3.2 Choice of method

Since the two main actors in the current wild boar supply chain are hunters and game dealers, and given that the wild boar supply chain relies on a dynamic relationship between the two, it was necessary to include both in the data collection. However, Sweden has a vast number of hunters; in 2019 there were approximately 250 000 active hunters (Eriksson et al. 2018). To approach a large and relatively representative number of hunters within the short timeframe for this study, a survey was sent out into the following three Facebook communities; “JAKT”, “Jägarliv” and “Vildsvinsjakt åteljakt och nattjakt”. The method is a quantitative method and was found suitable as it reached a high number of respondents resulting in data that could be quantified and used to identify different connections and trends.

Nevertheless, the second part of the study used a qualitative approach when targeting the game dealers. Semi-structured interviews with the game dealers were conducted in order to get a more thorough insight into how they operate their businesses, to understand their in- and outflows of wild boar meat and to identify potential challenges and opportunities. To summarise, the chosen method can be described as methodological triangulation which is a combination of qualitative and quantitative data collection methods (Greene & Caracelli 1997; Thurmond, 2001). Some researchers argue that the use of quantitative and qualitative methods in the same study is inappropriate since the two methods differ ontologically and epistemologically (Hunt 1991). However, Hussein (2009) argues that both methods are designed to create a better understanding of a subject and, since both have their strengths and weaknesses, it can be beneficial to use them simultaneously as they complement each other.

3.3 Case study

A case study is a research approach used to study a specific geographic area, phenomena, company or person (Bell & Bryman 2017). Traditionally, case studies have been criticised for lacking objectivity compared to other research approaches used in social science studies (Noor 2008; Rowley 2002). Still, it is a useful approach in exploratory and descriptive research (Noor 2008). A case study approach was chosen to analyse hunters and game retailers in the southern and middle part of Sweden. The geographical area of the case study is limited to the said areas since the wild boar population only exists south of Dalarna county, having the highest density in Skåne county and Södermanland county (Naturvårdsverket 2020).

Common weaknesses with case studies are firstly that the findings cannot generalise, and observer bias can occur i.e. the researcher tends to see the evidence that is expected to be seen (Rowley 2002). Nonetheless, Noor (2008) argues that multiple cases with similar findings can be used for generalisation. Another positive aspect with case studies is that the approach invites the researcher to retain a holistic

perspective (ibid.). Also, Rowley (2002) argues that triangulation is the greatest strength of case studies, meaning that the approach allows the researcher to collect data from different sources within the case.

In this study, the findings are not used to generalise other food supply chains, rather to explore challenges, opportunities and limitations in the development of a wild boar supply chain. Moreover, observer bias was minimised by reviewing and discussing the data with the authors, supervisors and other independent persons. Finally, triangulation was used to gather data and evidence from both hunters and game dealers.

3.3.1 Survey

The survey consisted of two sections, with 26 questions (Appendix 1). To begin with, the respondents were given the following background information:

> *"I am writing my master's thesis in sustainable food development at the Swedish University of Agricultural Sciences, SLU. At present, about 170,000 wild boars are shot annually (Naturvårdsverket, 2020), but only a fraction of the meat goes to shops and restaurants. Therefore, this thesis aims to investigate the possibilities and challenges of developing an efficient supply chain of wild boar meat. The survey is aimed at both hunters and non-hunters who consume meat. It takes about 5-10 minutes to answer and all answers are anonymous."*

The survey then started with a question asking which county the respondent lived in and whether or not the respondent is a hunter (Appendix 1). Thereafter, the first section of the questionnaire began with 14 questions relating to hunting and meat handling and followed with a second section containing 10 questions on consumption of wild boar meat. Lastly, the survey was concluded with the following two questions: "*What do you think should be done to promote the consumption of wild boar meat?*" and "*Do you have any ideas on how the supply chain for wild boar meat can be improved?*".

3.3.2 Interviews

The quantitative data collection method refers to eight semi-structured interviews with game dealers in Sweden. Semi-structured were chosen instead of structured

interviews as it offers more flexibility during the interviews and enables the interviewer to be more exploratory during the interview (Bryman & Bell 2017; Noor 2008). The interviews consisted of 18 pre-formulated questions (Appendix 2), although the conversations also explored other related topics, depending on the given situation. All interviews were conducted digitally due to Covid-19 and notes were taken during the interviews to secure the data. Based on the similarities of the answers from the interviews, the data collection was ended after eight interviews.

The following game dealers were interviewed:

Table 1. Interviewed respondents

Company name	Respondent	County
Ahla Mossens Vilthägn	Jonas Albjär	Skåne
Basunda gård	Ulrik Saanum	Östergötland
Johannishus Gods	Maria Wachtmeister	Blekinge
Skånska Vilt	Per-Ola Andersson	Skåne
Svenskt Viltkött	Sven-Åke Larsson	Västergörland
Tvärskogs vilt	Thomas Nilsson	Kalmar
Viltpoolen i Luleå	Karin Hanzén	Norrbotten
Vrena viltslakteri	Christer Olofsson	Södermanland

3.4 Generalisation, validity and reliability

According to Tsang (2014), generalisation of case studies is important as it contributes to the development of a theory. Nonetheless, generalisation can only be performed if the case study is compared and analysed together with the empirical findings. Moreover, generalisation is connected to validity which relates to the actual relevance of the data i.e.; are we measuring what we intended to measure

(Yin 2013). Thus, the validity is connected to the relevance of the choice of theoretical framework and determines if the data can be used to answer the research question or not (Bryman & Bell, 2017; Djurfeldt et al. 2003).

Reliability on the other hand, implies that the author guarantees that the studied reality is interpreted correctly (Bryman & Bell, 2017; Rowley 2008). Hence, another researcher shall be able to reproduce the same study (Rowley 2008). Case-studies have traditionally been criticised of having a subjective nature (Noor 2002; Rowley, 2008) and generally the human ability and interpretation affects the results in research (Holme & Solvang 1997). To assure reproducibility, this study aims to give a detailed description of the method and to review the data together with supervisors and individuals outside of the study.

3.5 Limitations

This study focuses on the first steps of the supply chain, concerning the hunters and the game dealers. The final steps of the supply chain i.e., restaurants, retailers and end consumers, were not included. It would have been interesting to target these groups to get a deeper understanding of the consumer end of wild boar meat supply chain. Also, the study could have focused on evaluating the consumers demand and their conception about wild boar meat. However, the initial problem starts in the beginning of the supply chain where the hunters exchange meat with the game dealers. Thus, as game dealers handle all legal meat, it can be concluded that the game dealers bear vast knowledge relating to subsequent parts of the supply chain. Data from hunters and game management are therefore enough to study the entire supply chain. Lastly, the African Swine fever, a viral disease that can affect domestic pigs as well as wild boars, is spreading throughout Europe (Blome et al. 2013). The disease has not yet reached Sweden and therefore it is unknown if it will, and if so, how it will affect the Swedish wild boar population (Bengtsson 2015). For this reason, the study will not deal with the disease's impact on the wild boar supply chain.

4 Results

4.1 Survey

In total 793 people responded to the survey, of which 670 considered themselves as hunters and 123 as non-hunters (Figure 2). Most hunters (12 percent) answered that they shoot approximately 10 wild boars per year, whereas the average hunter shoots 13 wild boars per year.

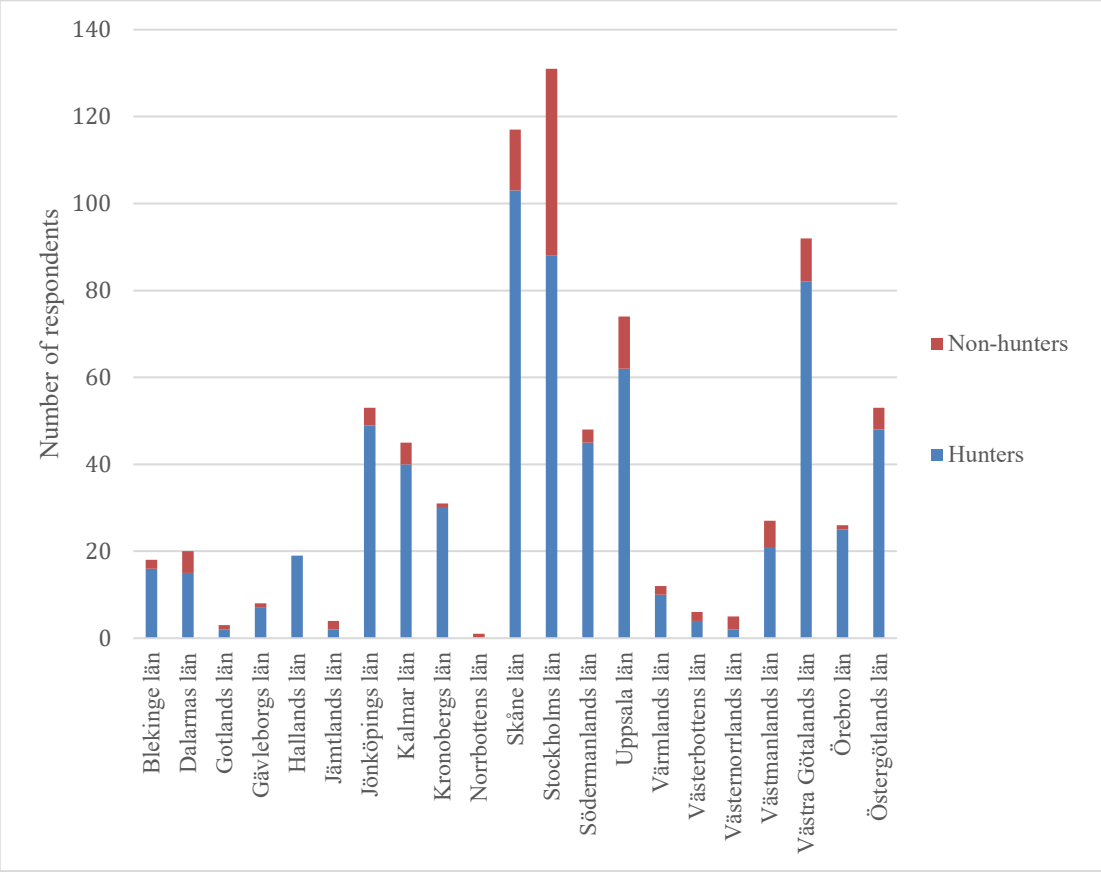

Figure 2 An overview of the respondents

4.1.1 Meat handling

The survey revealed that 66 percent of the hunters eviscerate the wild boars in a slaughtering facility, while 27 percent eviscerate in the forest (Figure 3). Moreover, 54 percent of the hunters dry-age the entire carcass in a cooling-room, whereas 38 percent do so in a cool and ventilated space (Figure 4). The hanging varied from one to 10 days, although the most common answer (29 percent) was applying the

40 day-degrees method. Almost all hunters (98.5 percent), responded that they always test the meat for Trichinella, whereas three out of 670 respondents (0.44 percent) only test the meat sometimes and seven (1.04 percent) never do.

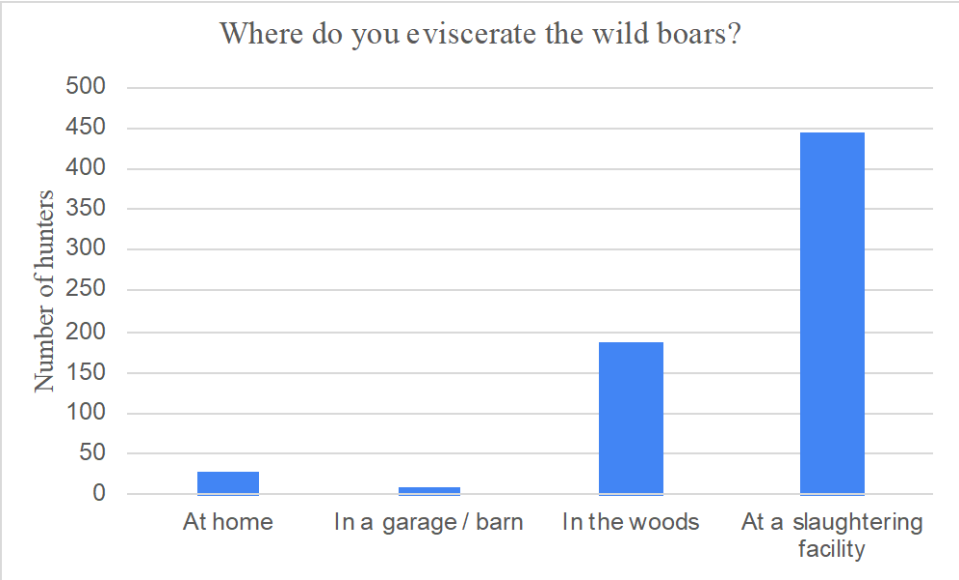

Figure 3 Evisceration

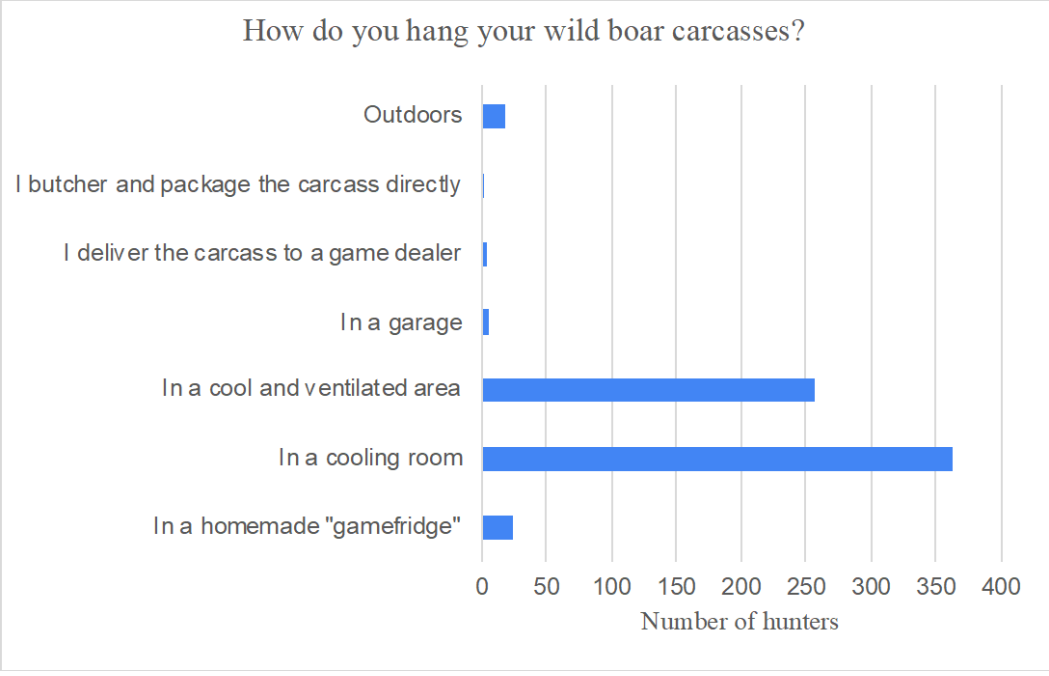

Figure 4 Hanging treatment

4.1.2 Meat sales and processing

A majority of the hunters (69 percent) always keep their wild boar meat for personal use and 17 percent give the meat away to family and friends. Also, six percent answered that they do a combination thereof, i.e. keep the meat for themselves, or sell the meat, or give it to their relatives. Somehow only four percent of the hunters sell the meat to a game dealer and two percent examine the meat at a game dealer and then sell it themselves. There are also three hunters (0.5 percent) that discard their meat and one hunter (0.15 percent) makes dog food out of the meat.

Furthermore, 36 percent argue that the existing regulations are the reason why they are not selling their meat, whereas 28 percent want to keep it for personal use, 17 percent argue that it is troublesome to sell it to a game dealer and 15 percent do not sell the meat because they find the remuneration too low (Figure 5). The findings also show that 87 percent of the hunters are willing to drive 0 - 50 kilometres to a game dealer to sell their meat and 13 percent are willing to drive 50 - 100 kilometres.

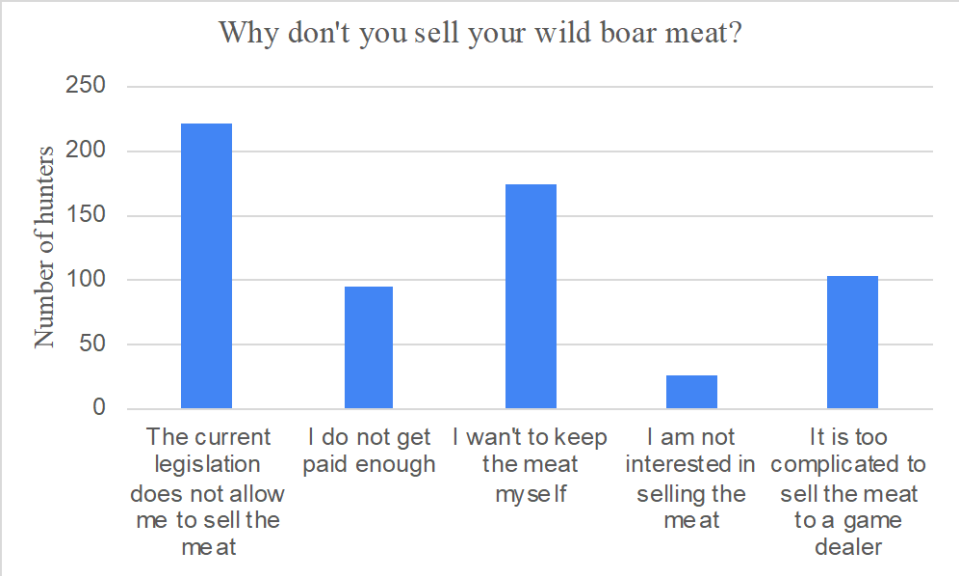

Figure 5 Reasons why hunters do not sell their meat

Moreover, the findings show that only five percent of the hunters are willing to sell their wild boar for 20 SEK per kilogram, whereas 24 percent are willing to

sell for 30 SEK per kilogram, and 48 percent for 40 SEK per kilogram (Figure 6). Lastly, 81 percent are willing to sell it for 50 SEK per kilogram, 92 percent would accept 60 SEK per kilogram, the rest would sell it for 60 SEK per kilogram or more.

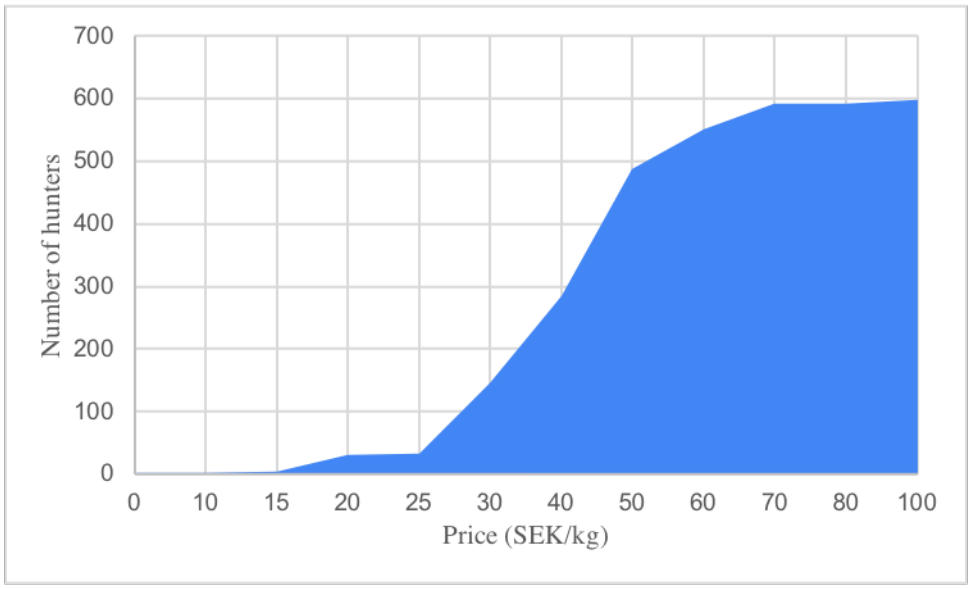

Figure 6 Hunters price acceptance for carcasses

On behalf of the Government, the National Food Administration (Regeringen 2020) is currently investigating the possibilities for hunters to sell wild boar meat directly to consumers, restaurants and retailers. One proposal is that hunters who have undergone a four hour game examiner training should be allowed to sell wild boar meat. Of the 670 asked hunters, 603 (90 percent) are willing to participate in the training if they're given the opportunity and only 37 (5.5 percent) don't want to participate at all. Hence, around four percent already have undergone the training and 0.4 percent are considering participating depending on the cost. The survey further shows that 46 percent of the hunters would hunt wild boars more frequently if it would be easier to sell the meat and 29 percent would consider increasing their hunting, whereas 25 percent would not (Figure 7).

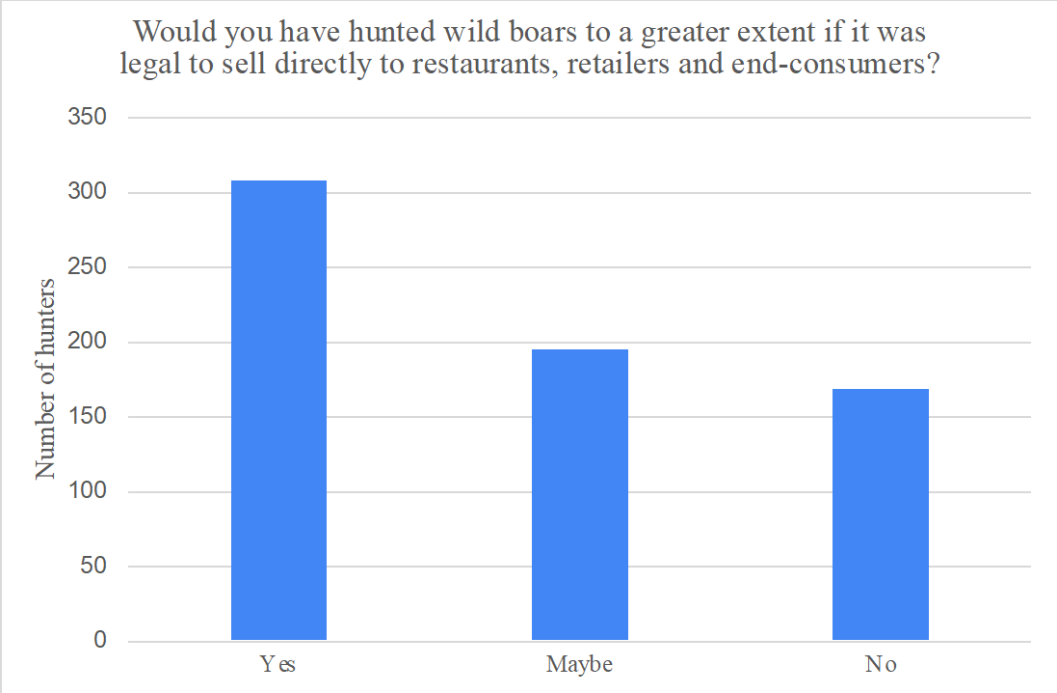

Figure 7 Increased hunting pressure and promoting sales of wild boar meat

Finally, Lantbrukarnas Riksförbund (LRF 2013) highlights the importance of refining wild boar meat into attractive products that the consumers are demanding, which will give incentives to increase the hunting pressure since the demand will increase. The survey findings show that 44 percent of the respondents would consume more wild boar meat if it was easier to refine the meat, whereby 25 percent are not certain if the refinement would affect their consumption and 30 percent would not increase their consumption (Figure 8). Furthermore, 37 percent of the hunters are interested in learning how to refine their wild boar meat, 30 percent are willing to pay for someone else to do so and 21 percent are willing to pay or trade meat for someone to refine the meat and then reclaim it.

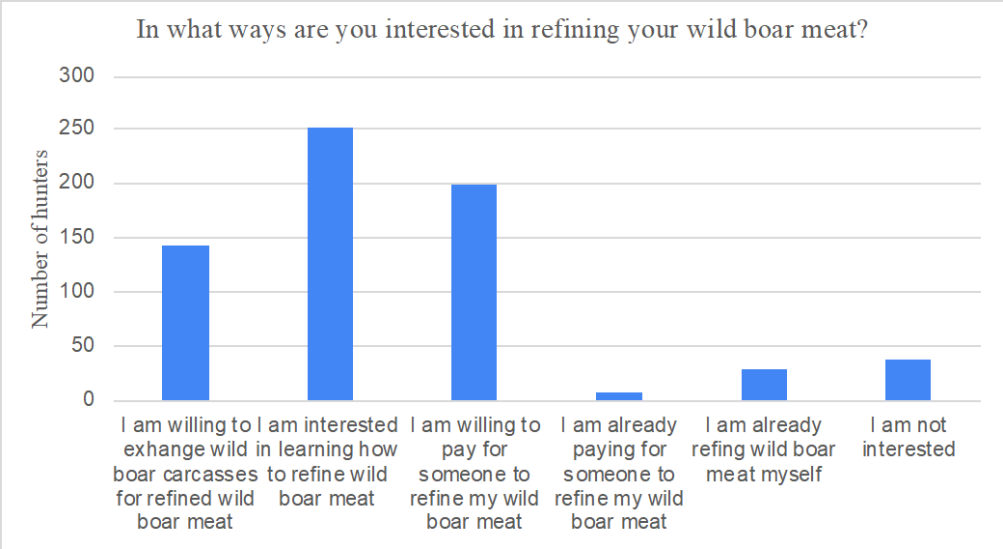

Figure 8 Refining wild boar meat

4.1.3 Consumption

Almost 99 percent of the hunters responded that they are consuming wild boar, whereby 86 percent of the non-hunters do and 14 percent don't. The majority of the non-hunters that don't consume wild boar meat claim the reason being the lack of supply. Moreover, 83 percent of the non-hunters eating wild boar only do so once a year, eight percent do so once a week, and 5 percent do so less than once a year. Of the non-hunters that have tried wild boar meat, approximately 35 percent have cooked it themselves whilst 47 percent have tried it at a restaurant or at a private dinner. The majority (85 percent) of the hunters have mainly consumed wild boar meat at home.

Furthermore, the findings show that the most common way for non-hunters to access wild boar meat is through relatives that are hunting (Figure 9). Of the non-hunters, 53 percent have bought or have received meat from relatives, 15 percent have bought it from a game dealer and 16 percent have bought it from the supermarket. As expected, the majority of the hunters (97 percent) were self-sufficient of wild boar meat and the remaining 3 percent received their meat from relatives.

Figure 9 How do you get hold of your wild boar meat?

At last, 44 percent of the hunters answered that they are not interested in buying wild boar products in a retail store. However, 23 percent answered that they are interested in buying wild boar sausages and charcuterie, and 21 percent answered that they are interested in buying all of the following products; minced meat, meat cuts, sausages and charcutiers. Among the non-hunters, eight percent answered that they are not interested in buying wild boar products in a retail store. However, 11 percent answered that they are interested in buying butchered meat cuts as well as sausages and charcuterie. Also, eight percent answered that they only are interested in buying meat cuts and four percent answered that they only are interested in sausages and charcuterie. Moreover, 45 percent of the non-hunters answered that they would buy all of the following wild boar products; minced meat, meat cuts, and sausages and charcuterie.

4.2 Interviews

In total, eight interviews with game dealers were conducted during this research and each interview consisted of 18 pre-formulated questions (Appendix 2). Many similarities were found in the game dealers' answers and the major findings will be summarized in this section.

To give some background on the situation of game dealers in Sweden, a study from Jordbruksverket (2013) shows that the majority of game dealers in Sweden handling wild boars are located in the southern counties where the wild boar population is most dense. The same study shows that there only exists one game dealer handling wild boars in Uppsala county, and none exist in Stockholm county (ibid.). Further, a study from Livsmedelsverket (2019) shows that there are 154 game dealers throughout Sweden, whence 71 are handling wild boars. Furthermore, there are approximately 10 game dealers in the Södermanland, Kronoberg, Kalmar and Skåne, all accounting for more than 80 percent of the total wild boar meat handling in 2018.

4.2.1 Challenges and limitations

When conducting the series of interviews, some challenges and limitations could be noted. For instance, a reoccurring argument made by all respondents was the importance of correct knowledge and skills when handling meat in order to be able offer safe products. All believed that the hunters' knowledge and skills are lacking in this regard, which often results in food losses due to quality deficiencies caused by faulty handling, (such as meat being contaminated or rotten). Thomas Nilsson at Tvärskogs Vilt believe that “many hunters care only about the meat handling when they intend to eat the meat themselves and don’t care about the meat handling when selling it to game dealers”. At the same time, all respondents are concerned that wild boar meat unsafe to consume, due to deficient meat handling, will reach the consumers and essentially impair the consumer's perception of wild boar meat. This is unfortunate, according to the respondents, as consumer perception of wild boar meat has been improving significantly in recent years as a result of extensive marketing efforts. (S-Å, Larsson, personal communication, 2020; P-O, Andersson, personal communication, 2020; T, Nilsson, personal communication, 2020).

Another common issue highlighted by respondents, is that game meat arriving from commercial hunts is often more damaged than meat originating from other hunts. This can be explained by hunters participating in commercial hunts are keen on hunting large numbers of animals at once, given that they have paid for the hunting

experience, and are therefore not as careful when shooting (T, Nilsson, personal communication, 2020; P-O, Anderson, personal communication, 2020). However, Maria Wachtmeister, manager of Johannishus, a hunting and agricultural estate in Blekinge offering commercial hunts, explained that they have a well-established system to assure good meat handling and quality (M, Wachtmeister, personal communication, 2020). Each year they arrange a couple of driven hunts at which up to 100 wild boars can be harvested on each occasion. To assure good meat handling and quality they have foresight and communication with the game dealers to assure they have a "*slaughter patrol*" collecting the game immediately after the end of the hunt. The game carcasses are then placed in mobile slaughtering facilities where the game is eviscerated and kept in a cooling-room. Thereafter, the meat is sold directly to restaurants, in Johannishus' farm shop and at the local REKO-ring (a local farmers' market).

Most game dealers confirmed having enough capacity to purchase from the hunters the quantities of meat demanded from the game distributors and end consumers. Thus, K, Hanzen at Luleå Viltpool admits that the game dealers always have wild boar meat available, but as some wild boar meat cuts are more popular than others, supplies of specific meat cuts are often sold out throughout the year. For instance, the wild boar loin is almost impossible to buy during the summer months and restaurants tend to demand the fattier cuts which creates a surplus of lean cuts such as the rump.

Lastly, other challenges and limitations shown throughout the conducted interviews regard the respondents' concerns about the Game Meat Investigator training that will potentially allow hunters who have completed the training to sell their meat directly to consumers (Livsmedelsverket 2020). The major concern is related to the food safety aspect; hunters are ignorant when handling the meat and will therefore supply the market with unsafe products that can potentially harm the consumer and the consumer's perception of wild boar meat.

4.2.2 Opportunities

The interviews did, however, also show positive aspects of wild boar meat. All respondents shared a common view of wild boar as a meat having good potential. Thomas Nilsson at Tvärskogs Vilt explained that he wishes to expand but needs to be certain that there is a strong market demand before doing so. As mentioned earlier, the demand for wild boar meat has increased during the recent years, yet a few game dealers argue that many consumers still have a negative perception of wild boar meat (S-Å, Larsson, personal communication, 2020; C, Olofsson, personal communication, 2020; M, Wachtmeister, 2020). Karin Hanzen at Luleå Viltpool on the other hand, argues that wild boar meat is already profitable today since it increases in value when being refined into other products such as sausages and charcuteries. Demand can also be seen to expand into other areas than meat sales, as game dealers have experienced an increasing demand from hunters to provide butchering as a service (P-O, Andersson, personal communication, 2020; U, Saanum, personal communication, 2020; J, Albjär, personal communication, 2020; T, Nilsson, personal communication, 2020).

Unmanned game storage depots are a recent initiative frequently seen in counties with large wild boar populations, such as Skåne, Östergötland and Blekinge (T, Nilsson, personal communication, 2020; P-O, Andersson, personal communication, 2020; M, Wachtmeister, personal communication, 2020). These depots have cooling facilities and are open 24-hours a day for hunters to drop off wild boar carcasses as well as other game species. The hunter checks-in digitally, tags the animal and hangs it in the facility. Thereafter, the game dealers collect all carcasses on a frequent basis whereby the animal is inspected. Once the animal is approved by the game dealer, the hunter is paid depending on the quality of the meat, which is determined by the animal's age, sex, how it was shot and how the meat was handled (T, Nilsson, personal communication, 2020; P-O, Andersson, personal communication, 2020; U, Saanum, personal communication, 2020; J, Albjär, personal communication, 2020). Thus, the pricing for wild boars that are larger than 10 kilos, varies between 15 and 18 SEK per kilogram. The respondents had different opinions on whether or not game storage depots are a good system. One concern is

that hunters will abuse the use of the depots as they might use them for personal use only (T, Nilsson, personal communication, 2020). Therefore, food safety could be affected given that the game dealers lose control of the supply chain when not having insight in the depots (S-Å, Larsson, personal communication, 2020).

Furthermore, by including wild boar meet in kitchens in the public sector, all respondents saw a potential growth in the demand for wild boar meat. Some have already noted an increasing demand in the public sector and hope it will continue to rise (J, Albjär, personal communication, 2020; U, Saanum, personal communication, 2020; S-Å Larsson, personal communication, 2020; P-O, Andersson, personal communication, 2020). It was further noted that the public sector tends to demand the cheaper parts, such as stew and minced meat, since being on a limited budget (K, Hanzen, personal communication; T, Nilsson, personal communication; P-O, Andersson, personal communication, 2020; U, Saanum, personal communication, 2020).

Finally, the majority of the game dealers found potential in the use of digital tools and traceability to ease the communication with hunters and to assure consumers that the meat is safe to consume (T, Nilsson, personal communication, 2020; S-Å, Larsson, personal communication, 2020; K, Hanzen, personal communication, 2020).

5 Analysis and Discussion

5.1 The existing wild boar supply chain

The existing wild boar supply chain starts with hunters, also seen as primary producers (Beamon 1999; Georgiadis et al. 2005). The food chain can vary in complexity and size from short food supply chains (Beamon 1999) to larger national food chains. The short food supply chains, in which there is a direct link between the producer and end consumer, represent the meat sold in farm shops by game dealers directly to consumers, as well as the meat sold or given away by hunters directly to relatives and other private individuals. The larger food chains represent the meat sold by the game dealers either to game distributors such as Viltpoolen (K, Hanze, personal communication, 2020), or directly to restaurants, retailers and municipalities. A study from Livsmedelsverket (2019) shows that 10 of the 64 game dealing facilities in Sweden handling wild boar meat account for 80 percent of all the handled wild boar meat, which point out that the existing supply chain is concentrated to a small group of game dealers. The same study shows that of all 154 game dealers in Sweden, many do not handle wild boars at all.

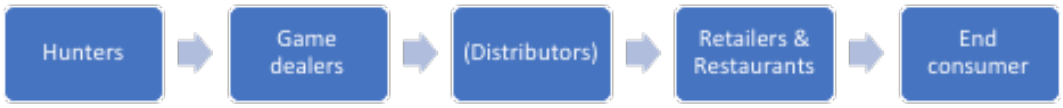

Figure 10 Illustration of the wild boar supply chain

5.2 Challenges and limitations

Food safety is an important part of a sustainable food system (FAO 2018) and wild game meat can from this perspective, be seen as a more perilous food compared to livestock meat. The reason for this is twofold; firstly, the meat is, in contrast to livestock meat, initially harvested by hunters that in most cases lack education on meat handling. Secondly, the wild boar can carry Trichinella as well as other pathogens, diseases not found in other commonly consumed game species (Naturvårsverket 2020). To assure food safety, the Swedish government (Regeringen 2020) requires that all wild boar meat is examined and processed at an

approved game management facility. However, all interviewed game dealers, who essentially are the ones performing the examination and processing, are concerned with the proposed legislation allowing trained hunters to sell their wild boar meat directly to retailers, restaurants and end consumers. They argue that this is a food safety issue since most hunters are lacking knowledge about meat handling which impairs the meat quality. The fact that approximately 140,000 wild boars are harvested per year in Sweden but only 15 percent of the meat reaches the market is a food safety issue as well as a food loss issue. The survey findings point out that approximately 22 percent of the hunters either sell or give their meat away, supporting the game traders' belief that much of the wild boar meat reaches the illegal market (i.e. sold to private individuals without interfering with the game dealers). This in turn entails that there is no guarantee whether the meat purchased has been tested for Trichinella and handled in a food-safe manner. Furthermore, less than one percent of the hunters discard the wild boar meat, which leads to food losses. It should be mentioned that it is difficult not to discard any meat at all, since the animals are shot which leads to inevitable damages in the meat. However, the majority of the food losses are found when game dealers receive carcasses in such bad shape, because of inadequate handling or extensive shooting, that they are forced to discard all meat.

The survey findings further show that almost a third of the hunters eviscerate their wild boars in the forest, whereas the remaining hunters eviscerate in a slaughtering facility (Figure 3). Almost all hunters always test the wild boars for *Trichinella*, however, three respondents only test the meat sometimes and seven never test at all. As mentioned earlier, the main purpose of a food system is to supply the population with nutritious and safe food (FAO 2018). From a food safety perspective, the testing frequency for Trichinella among hunters is satisfying, but it is concerning that many hunters eviscerate wild boars in the forest since it can contaminate the meat.

Moreover, the findings show that 69 percent of the hunters always keep their harvested wild boar meat for personal use, but that 4 percent sell their meat to the

game dealers and two percent pay the game dealers to butcher their carcasses. The fact that only a fraction of the meat reaches the game dealers seems to correlate with the distance between the hunter and the game dealer's location as well as with the pricing. The fact that 87 percent of the hunters are not willing to drive more than 50 kilometres to sell their carcasses to a game dealer shows that location of the game dealers is important. At the same time, there are contradictions between hunters and game dealers regarding the pricing of wild boar meat. Only five percent of the respondents are willing to sell wild boar carcasses for 20 SEK per kilogram (Figure 6), which is slightly more than the game dealers are willing to pay. Almost a fourth of the hunters would accept 30 SEK per kilo and 48 percent would accept 40 SEK per kilogram. However, 81 percent of the hunters would accept 50 SEK per kilogram and the rest would accept 60 SEK per kilogram or higher. Another obstacle for hunters to sell their meat is the distance to the game dealers.

All game dealers argue that the demand for unprocessed wild boar meat is lower than the demand for equivalent meat from deer and moose. Therefore, a major challenge to increase the supply is to create higher demand for wild boar meat. The proposed change in the existing regulation aiming at enabling hunters to sell their wild boar meat might be a possible solution to increasing supply but could also be a food safety issue if the meat handling is not improved.

5.3 Opportunities

The Swedish livestock production plays a big part in the national food system and the consumption of frozen and fresh meat from livestock production has increased dramatically during the past 30 years (Jordbruksverket 2019). As the FAO (2018) argues, a sustainable food system shall provide safe and nutritious food without compromising environmental, social and economic conditions to produce food for future generations. Since livestock production is a major cause to climate change (Bailey et al 2014; UNEP 2016) and the wild boar population is increasing dramatically (Livsmedelsverket 2019; Jordbruksverket 2013; Malmfors & Wilklund 2014), it would be suitable to substitute livestock meat with wild boar meat. Compared to livestock production, wild boar game meat requires much less

resource intense inputs and can be considered to be more ethical from an animal welfare perspective.

As mentioned earlier, the survey findings show that the limit of how far most hunters are willing to travel to sell their meat is up to 50 kilometres, entailing that the game dealing facilities need to be situated close to the hunters. Thus, many of the game dealers argue that initiatives such as unmanned game storage depots are an effective incentive to get hunters to sell their meat. Most of the interviewed respondents had positive experience from game storage depots. However, depots are only present in counties from Södermanland and further south in Sweden. Yet, there are no such depots in Stockholm county or Uppsala county, two counties with a dense wild boar population. The lack of game dealers in these counties reveals a strong opportunity to open new facilities and unmanned depots.

Furthermore, game dealers are paid less for wild boar meat than meat from other game species since the demand is lower. Official statistics support this information as consumption of wild game meat per capita has decreased with 25 percent during the past 30 years (www.jordbruksverket.se). An effort that potentially will lead to increased demand is to increase the servings of wild boar meat in the public sector, which also is one of the main aims of the National wild boar management plan from Naturvårdsverket (2020). However, the demand for refined wild boar products seem to be higher than compared to butchered meat cuts and mince. Some game dealers argue that they are paid the same amount for refined wild boar products as for similarly refined moose and deer products. This creates an opportunity to produce profitable refined wild boar meat products since the inputs are cheaper. Further, the study findings show that most hunters would increase their hunting if it was easier to sell and refine the meat (Figure 7), which entails that wild boar hunting would increase. Increased hunting would lower agricultural damages caused by wild boars as well as traffic accidents, which contributes to economic sustainability.

5.4 Discussion

Overall, the development of an efficient wild boar supply chain relies on a balance between food safety and increased supply. In contrast to other game species, the wild boar sales is regulated by Regulation 2016/429 of the European Parliament, since wild boar meat can carry pathogens and parasites such as Salmonella spp, Yersinna spp, and *Thrichinella* and *Toxoplasma gondii* (Livsmedelsverket 2019; Naturvårdsverket 2020; EFSA 2013). Wild boar meat can also contain radioactive levels of cesium as well as lead fragments caused by lead-based bullets, which both can be harmful to the consumer's health (Livsmedelsverket 2019; Arnemo et al. 2016). Due to the legislation, the sales of wild boar meat are more complicated than for other game species.

As mentioned earlier, the new legislation enabling hunters to sell their wild boar meat might increase the market supply temporally and could provide the market with hazardous meat. The survey findings show that many hunters are handling the meat in slaughtering facilities (Figure 3), but a significant portion the hunters are eviscerating their meat in the forest and hang it in non-appropriate facilities (Figure 4). Game dealers above all have better knowledge than ordinary hunters, but in addition they operate in professional slaughtering facilities which increases food safety. To assure food safety it is therefore necessary that game dealers examine the meat, since the wild boar meat can contain various parasites, pathogens, cesium and lead fragments. The fact that many of the interviewed game dealers argued that they will probably stop accepting wild boars if the legislations will change is also concerning. However, hunters will probably not be able to fulfil the demand for large quantities of specific wild boar meat cuts from the public sector and restaurants. It is therefore likely that game dealers will maintain their position in the supply chain if the new legislation come into effect, essentially undermining the entire aim with the legislation.

The survey findings further demonstrate that almost all hunters test their meat for *Trichinella,* which is a promising habit for when the new legislation will come into force. Nevertheless, a suggestion is that the testing also would involve Salmonella

spp, Yersinna spp, *Toxoplasma gondii* and *Cesium* and Lead fragment. To guarantee a high-testing frequency, the government could further subsidise the testing cost. Another potential solution is to heat treat the meat, provided that it does not affect the taste. Furthermore, another suggestion is to improve the hunters' meat handling through education. Additionally, the new legislation proposes that the hunters who have undergone a 4-hour game investigation education, will be allowed to sell wild boar meat directly to restaurants, retailers and end-consumers. The findings show that 90 percent of the hunters are willing to undergo this education, but on the other hand the game dealers argue that the training is lacking practical elements. Therefore, another suggestion is to include practical elements within the game investigator training. Preferably, training should be conducted by the game dealers which will further benefit the relationship and exchange between hunters and game dealers.

In contrast to new legislations, another option that could encourage hunters to sell their food and at the same time contribute to food safety, is to improve the exchange among hunters and game dealers. The findings show that many hunters are interested in getting help with butchering and refining their wild boars. Therefore, a potential solution to even out the discrepancy regarding pricing could be a subsidy financing a part of the fee hunters pay to the game dealer for assistance with butchering and refining. However, as previously mentioned, the game dealers' drop-off locations need to be close to the hunters which can be solved with an increased number of unmanned game storage depots. Another opportunity is to increase the communication between hunters and game dealers so that the game dealers know in advance when the hunt is taking place and therefore can coordinate the logistics. As a suggestion, the game dealers could place a mobile slaughtering facility or a game storage depot close to the hunting area. Thus, game dealers can handle large quantities at the same occasion, which provides economies of scale. In return, the game dealers will possibly pay the hunters more for the meat.

Furthermore, the wild boar demand has to be increased to develop a more efficient supply chain. The negative perception of wild boars probably has a negative impact

on the demand for wild boar products. Therefore, marketing effort and education has to be focused on highlighting positive factors of wild boar meat such as increasing biodiversity, good animal welfare and that the meat (if handled correctly) is healthier and leaner than other meat. Livestock production is the largest GHG emitter within the agricultural sector (Bailey et al. 2014; Pirog et al. 2001) and the land use is often causing major biodiversity losses (FAO 2016). From this perspective wild game can be considered as meat with low environmental impact, since there are low inputs required to harvest the meat. On the other hand, the wild boars contribute to agricultural damages when rooting for food feed (Månsson et al. 2010) which causes a yearly cost around 1.315 billion SEK (Gren et al. 2019). To increase the demand for wild boar meat, a suggestion is to increase the servings of wild boar meat in the public sector. It will have a direct effect on the demand, but more importantly, many consumers who are unfamiliar with wild boar meat will have the opportunity to try it. Nonetheless, it is important that the servings are taste good in order for the consumers have a positive experience and will continue their consumption. Therefore, the public sector could collaborate with Grythyttan School of Hospitality, Culinary Arts & Meal Science, chefs and organisations such as Svenskt Viltkött, to develop tasty and affordable wild boar dishes. Moreover, a majority of the survey respondents are interested in buying wild boar charcuteries and sausages. Many of the game dealers also argue that refined wild boar products are more profitable than unprocessed wild boar meat, meaning that there is a good opportunity further develop wild boar charcuterie, sausages and other refined products.

As Elinkton (1999) argues, long term sustainability is created between the interrelated three pillars of sustainability; economic, social and environmental.
Wild boar meat does not require such resource-intensive inputs as livestock meat, which increases the environmental sustainability. The agricultural damages are however an economical loss for the farmers, affecting the economic sustainability. Nonetheless, damages can possibly be lowered if the wild boar hunting and management increases, as an effect of increased demand for wild boar meat. Moreover, an increased demand for wild game meat would generate new job

opportunities, and the nutritious and lean game meat may have long term health benefits, contributing to social sustainability. However, a reduced demand for livestock meat can lead to job losses, but the affected farmers could in such case switch production to plant- or vegetable cultivation instead. The wild boar meat is an unutilized resource, that with a more efficient supply chain, will contribute to long term sustainability.

6 Conclusion

The purpose of this study has been to create a better understanding of how an efficient supply chain of wild boar meat can be developed in Sweden. The sales of wild boar meat are regulated by legislations to assure food safety since the meat can contain pathogens, parasites and cesium, compared to other Swedish game species. Nowadays, only 15 percent of the harvested wild boar meat reaches the wild boar market. To answer the purpose and the research question: "*What are the main factors that inhibits wild boar meat from reaching the market?*", the data has been analysed from a Food Safety Approach (FSA).

A central part of the food system is food safety, meaning that the system should produce nutritious and healthy food. Since wild boar meat can be hazardous, if not evaluated and handled correctly, it is of great importance that the meat is evaluated by the game dealers. The findings therefore show that the proposed legislation change is a trade-off between increased wild boar supply and food safety. Furthermore, the findings reveal two main factors that inhibits wild boar meat from reaching the market nowadays. Firstly, the pricing discrepancy between game dealers and secondly the geographical distance between hunters and game dealers. The majority of the hunters are demanding 45 SEK per kilogram or more to sell their game and the game dealers can offer between 15 and 20 SEK per kilogram. Also, most hunters are willing to travel up to 50 kilometres to sell their meat.

Finally, wild boar meat is a vastly underutilized resource that, with a more efficient wild boar supply chain, will contribute to long term sustainability mainly because it has a lower impact on the environment than livestock meat, but also since a more efficient wild boar supply chain will lower economic costs that derives from agricultural damages and traffic accidents.

References

Litterature

A.D. Goguen, S.J. Riley, J.F. Organ, B.A. Rudolph Wild-harvested venison yields and sharing by Michigan deer hunter Human Dimension of Wildlife, 23 (3) (2018), pp. 197-212

Arnemo, J.M., Andersen, O., Stokke, S., Thomas, V.G., Krone, O., Pain, D.J. and Mateo, R., 2016. Health and environmental risks from lead-based ammunition: science versus socio-politics. EcoHealth, 13(4), pp.618-622.

Bailey, R., Froggatt, A. and Wellesley, L., 2014. Livestock–climate change's forgotten sector. Chatham House.

Bengtsson, J., 2015. Afrikansk svinpest hos vildsvin.

Blome, S., Gabriel, C. and Beer, M., 2013. Pathogenesis of African swine fever in domestic pigs and European wild boar. *Virus research*, *173*(1), pp.122-130.

Brunet, H. (2016). Disturbance of the herbaceous layer after invasion of an eutrophic temperate forest by wild boar. Nordic journal of botany, vol. 34 (1), pp. 120–128 Oxford, UK: Blackwell Publishing Ltd.

Bryman, A. & Bell, E., 2017. Företagsekonomiska forskningsmetoder Upplaga 3., Stockholm: Liber.

Djurfeldt, G., Larsson, R. and Stjärnhagen, O., 2003. Statistisk verktygslåda-samhällsvetenskaplig orsaksanalys med kvantitativa metoder.

Elkington, J. (1999). Cannibals with Forks: The Triple Bottom Line of 21st Century Business. Oxford, the UK: Capstone Publishing Limited

Ericsson, G., Sandström, C., Kindberg, J. and Støen, O.G., 2010. Om svenskars rädsla för stora rovdjur, älg och vildsvin. Swedish University of Agricultural Sciences, Umeå, Sweden [In Swedish]. Report, 1.

Ericksen, P.J., Ingram, J.S. and Liverman, D.M., 2009. Food security and global environmental change: emerging challenges.

Ericksen, P., Stewart, B., Dixon, J., Barling, D., Loring, P., Anderson, M. and Ingram, J., 2010. The value of a food system approach. Food security and global environmental change, 25, pp.24-25.

Eriksson, M., Hansson-Forman, K., Ericsson, G. and Sandström, C., 2018. Viltvårdsavgiften: En studie av svenskarnas vilja att betala det statliga jaktkortet.

Falguera, V., Aliguer, N. and Falguera, M., 2012. An integrated approach to current trends in food consumption: Moving toward functional and organic products?. Food Control, 26(2), pp.274-281.

Georgiadis, P., Vlachos, D. and Iakovou, E., 2005. A system dynamics modeling framework for the strategic supply chain management of food chains. Journal of food engineering, 70(3), pp.351-364.

Gerber, P. J., H.Steinfeld, B.Henderson, A.Mottet, C.Opio, J.Dijkman, A.Falcucci, and G.Tempio. 2013. Tackling climate change through livestock: a global assessment of emissions and mitigation opportunities. Rome: FAO Available at: http://www.fao.org/3/a-i3437e.pdf

Godfray, H.C.J., Crute, I.R., Haddad, L., Lawrence, D., Muir, J.F., Nisbett, N., Pretty, J., Robinson, S., Toulmin, C. and Whiteley, R., 2010. The future of the global food system.

Greene, J.C. and Caracelli, V.J., 1997. Advances in mixed-method evaluation: The challenges and benefits of integrating diverse paradigms.

Green, B.N., Johnson, C.D. and Adams, A., 2006. Writing narrative literature reviews for peer-reviewed journals: secrets of the trade. Journal of chiropractic medicine, 5(3), pp.101-117.

Gren, I-M, Andersson, H & Elofsson, K. (2019). Kostnader och värden av vildsvin i Sverige.

Hoffman, L.C. and Wiklund, E., 2006. Game and venison–meat for the modern consumer. Meat science, 74(1), pp.197-208.

Hunt, S.D., 1991. Modern marketing theory: Critical issues in the philosophy of marketing science. South-Western Pub.

Hussein, A., 2009. The use of triangulation in social sciences research: Can qualitative and quantitative methods be combined. Journal of comparative social work, 1(8), pp.1-12.

Lantbrukarnas Riksförbund. 2013. LRFs vildsvinspolicy, sammanfattande dokument 2013-12-10. Tillgängligt elektroniskt: http://www.lrf.se/PageFiles/13378/Vildsvinspolicy2013.pdf

Lipinski, B., Hanson, C., Lomax, J., Kitinoja, L., Waite, R. and Searchinger, T., 2013. Reducing food loss and waste. World Resources Institute Working Paper, 1, pp.1-40.

Malik, S., Kanhere, S.S. and Jurdak, R., 2018, November. Productchain: Scalable blockchain framework to support provenance in supply chains. In 2018 IEEE 17th International Symposium on Network Computing and Applications (NCA) (pp. 1-10). IEEE.

Marescotti, M.E., Caputo, V., Demartini, E. & Gaviglio, A. (2019). Discovering market segments for hunted wild game meat. Meat science, vol. 149, pp. 163–176 England: Elsevier BV.

Martinez, S., 2010. Local food systems; concepts, impacts, and issues. Diane Publishing.

McMichael, A.J., Powles, J.W., Butler, C.D. and Uauy, R., 2007. Food, livestock production, energy, climate change, and health. The lancet, 370(9594), pp.1253-1263.

Månsson, J., Levin, M., Larsson, I. and Ängsteg, I., 2010. Besiktning av skador på gröda orsakade av vildsvin.

Noor, K.B.M., 2008. Case study: A strategic research methodology. American journal of applied sciences, 5(11), pp.1602-1604.

Pirog, R.S., Van Pelt, T., Enshayan, K. and Cook, E., 2001. Food, fuel, and freeways: An Iowa perspective on how far food travels, fuel usage, and greenhouse gas emissions.

Rowley, J., 2002. Using case studies in research. Management research news.

Röös, E. (2014). Mat-klimat-listan version 1.1 . Uppsala: Institutionen för energi och teknik, Sveriges lantbruksuniversitet.

K. Stamoulis, A. Zezza, 2003. A conceptual framework for national agricutural, rural development and food security strategies and policies. ESA Working Papers. FAO, Agricultural and Development Economics Division, Rome, Italy.

Tansey, G. and Worsley, A., 2014. The food system. Routledge.

Tham, M (2004). Vildsvin – beteende och jakt. Stockholm: Prisma

Thulin, C.G. and Röcklinsberg, H., 2020. Ethical Considerations for Wildlife Reintroductions and Rewilding. Frontiers in Veterinary Science, 7, p.163.

Thurmond, V.A., 2001. The point of triangulation. Journal of nursing scholarship, 33(3), pp.253-258..

Tsang, E.W., 2014. Generalizing from research findings: The merits of case studies. International Journal of Management Reviews, 16(4), pp.369-383.

Weidema, B., Wesnaes, M., Hermansen, J., Kristensen, T., Halberg, N., 2008. Environmental Improvement Potential of Meat and Dairy Products. Report No.: EUR 23491 EN. European Commission Joint Research Centre.

Welander, J. (2000). Spatial and temporal dynamics of wild boar (Sus scrofa) rooting in a mosaic landscape. Journal of zoology (1987), vol. 252 (2), pp. 263–271

Wiklund, E. & Malmfors, G. (2014). Viltkött som resurs . Stockholm: Naturvårdsverket.

Yin, R.K., 2013. Validity and generalization in future case study evaluations. Evaluation, 19(3), pp.321-332.

Reports

EFSA Panel on Biological Hazards (BIOHAZ), 2013. Scientific Opinion on the public health hazards to be covered by inspection of meat from farmed game. *EFSA Journal, 11(6),* p.3264.

Europaparlamentets och rådets förordning (EG) 852/2004 of 29 April 2004 on the hygiene of foodstuffs. https://eur-lex.europa.eu/legal-content/SV/TXT/?qid=1565178108906&uri=CELEX:32004R0852

FAO (2016). GREENHOUSE GAS EMISSION from Agriculture, Forestry and Other Land Use. Available at: http://www.fao.org/3/a-i6340e.pdf

Jordbruksverket (2013). Från skog till krog – Vilka hinder motverkar mer vildsvinskött på marknaden? Rapport 2013:28. Available at: https://www2.jordbruksverket.se/webdav/files/SJV/trycksaker/Pdf_rapporter/ra13_28.pdf

Jorbruksverkets statistikdatabas. Direktkonsumtion efter vara. Available at: http://statistik.sjv.se/PXWeb/pxweb/sv/Jordbruksverketspercent20statistikdatabas/Jordbruksverketspercent20statistikdatabas__Konsumtionpercent20avpercent20livsmedel/JO1301K1.px/table/tableViewLayout1/?rxid=5adf4929-f548-4f27-9bc9-78e127837625

Livsmedelsverket (2019). LIVSMEDELSVERKETS REGERINGSUPPDRAG – AVSÄTTNING AV SVENSKT VILDSVINSKÖTT. Available at: https://www.livsmedelsverket.se/globalassets/om-oss/regeringsuppdrag/regeringsuppdrag-avsattning-av-vildsvin-2018-02334.pdf

Naturvårdsverket (2020). Nationell förvaltningsplan för vildsvin. Gäller 2020-2025. Available at: https://www.naturvardsverket.se/Documents/publikationer6400/978-91-620-6926-1.pdf?pid=26428

Regeringen (2020). Vildsvinspaketet: https://www.regeringen.se/4a73c5/contentassets/234f4c66a4c4466b98ac60e2d4f2b686/uppdrag-att-genomfora-atgarder-i-vildsvinspaketet-inom-ramen-for-livsmedelsstrategin-livsmedelsverket2.pdf

UNEP. 2016. Food Systems and Natural Resources. A Report of the Working Group on Food Systems of the International Resource Panel. H. Westhoek, J. Ingram, S. Van Berkum, L. Özay, and M. Hajer. https://www.resourcepanel.org/reports/food-systems-and-natural-resources.

UNEP (United Nations Envionment Programme), 2010. Assessing the Environmental Impacts of Consumption and Production: Priority Products and Materials. A Report of the Working Group on the Environmental Impacts of Products and Materials to the International Panel for Sustainable Resource Management.

Appendix 1.

Survey layout

"I am writing my master's thesis in sustainable food development at the Swedish University of Agricultural Sciences, SLU. At present, about 170,000 wild boars are shot annually (Naturvårdsverket, 2020), but only a fraction of the meat goes to shops and restaurants. Therefore, this thesis aims to investigate the possibilities and challenges of developing an efficient supply chain of wild boar meat. The survey is aimed at both hunters and non-hunters who consume meat. It takes about 5-10 minutes to answer and all answers are anonymous."

<u>Where in Sweden do you live?</u>

Blekinge county
Dalarna county
Gotland county
Gävleborg county
Halland county
Jämtland county
Jönköping county
Kalmar county
Kronoberg county
Norrbotten county
Skåne county
Stockholm county
Södermanland county
Uppsala county
Värmland county
Västerbotten county
Västernorrland county
Västmanland county
Västra Götaland county
Örebro county

Östergötland county

Section 1. Hunting and meat handling

1. Do you hunt wild boar?

Yes

No

2. How many wild boars do you shoot in a year?

3. Where do you usually eviscerate the wild boars?

In the forest

In a slaughtering facility

Other:

4. How do you store the carcass?

In a cooling facility

In a cool and ventilated area

Outdoors

Other:

5. How long do you dry-age the carcass?

6. How often do you analyze the wild boar for trichinella?

Never

Sometimes

Always

Other:

7. What are you doing with the wild boar meat?

I keep it for personal use

I sell it to a game dealer

I examine the meat at an approved game slaughtering facility and then sell it by myself

I give it away to family and friends

I bury it or dispose it in some other way

Other:

8. What is the reason why you do not sell wild boar meat at the moment?

* Ignore this question if you are already selling wild boar meat

I want to keep the meat myself

I get paid too poorly

Complicated to sell to game dealers

The current legislation means that I cannot sell it

I'm not interested in selling wild boar meat

Other:

9. How far can you imagine going to leave and sell wild boar to a game dealer?

* Ignore this question if you are not interested in selling wild boar meat

0 - 50 kilometres

50 - 100 kilometres

100 - 150 kilometres

150 - 200 kilometres

Further than 200 kilometres

10. At what price can you imagine selling wild boar carcasses?

* Ignore this question if you are not interested in selling wild boar meat

20 SEK / kg

30 SEK / kg

40 SEK / kg

50 SEK / kg

60 SEK / kg

70 SEK / kg

Other:

11. On behalf of the Government, the National Food Administration is currently investigating the possibilities for hunters to sell wild boar meat directly to private individuals, restaurants and shops. One proposal is that hunters who have undergone a 4-hour game investigation training should be allowed to sell wild boar meat. Would you consider undergoing such training?

Yes

No

Other:

12. Would you have hunted wild boar to a greater extent if it was allowed to sell the meat to private individuals, shops and restaurants?

Yes

No

Other:

13. Are you interested in getting help to process your wild boar meat, for example for sausages and charcuterie products?

Yes, I am interested in learning to refine the meat myself

Yes, I'm willing to pay for someone else to process my meat

Yes, I can imagine giving away / selling wild boar for a return in the form of processed meat

No, I'm not interested

Other:

14. Would you consume wild boar meat to a greater extent if it was easier to process the meat?

Yes

No

Maybe

Other:

Section 2. Consumption

15. Do you consume wild boar meat?

Yes

No

16. If not, what is the reason you do not eat wild boar meat?

17. How often do you eat wild boar meat?

Never

A few times a year

Several times a month

Every week

Daily

18. On what occasions have you eaten wild boar meat?

At a restaurant

Have cooked it myself

Have eaten there when I have been invited to dinner

Have never eaten wild boar meat

Other:

19. How did you get hold of wild boar meat?

I've hunted it myself

I bought it in the grocery store

I bought it from a game dealer

From a friend or acquaintance who hunts

I have not been able to get it

Other:

20. What wild boar products would you like to buy in a store?

Wild boar mince

Finely chopped meat details

Sausages and charcuterie products

I'm not interested in buying wild boar meat

Other:

21. Do you find it difficult to get hold of wild boar meat?

Yes

No

Other:

22. What do you think should be done to promote the consumption of wild boar meat?

23. Do you have any ideas of your own on how the supply chain for wild boar meat can be improved?

24. Do you have something else you want to add?

Appendix 2.

Interview questions

1. Could you please tell me about your business - what is your business idea?
2. How long have you been around and who are your customers?
3. How does communication with hunters take place?
4. What kind of game do you handle?
5. How and where do you process the meat?
6. How do you experience the meat handling of hunters?
7. How has the growth of the wild boar population affected your business?
8. What is the biggest challenge in handling wild boar meat?
9. How do you ensure a constant supply of wild boar meat?
10. How much wild boar meat do you get in and how much do you need to discard?
11. What is the main reason why meat needs to be discarded?
12. Do you accept individual animals, if not - where does the border go?
13. How do you assess and price the meat quality?
14. What do you pay for wild boar meat and what do you get paid for it?
15. How do you feel the demand for wild boar meat is?
16. What initiatives are there to encourage hunters to sell their meat (e.g. game depots)?
17. What do you think would make it easier for hunters to sell their meat to game dealers? Do you have any ideas?
18. Do you know anything about the market abroad? How do they do in Germany for example?
19. What do you think about the new proposal for game research training?